Broadband SW Aerosol Optical Properties Using MATCH and OPAC Data

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Third CERES-II Science Team Meeting
Princeton, New Jersey
3-5 May 2005

Objective and Motivation

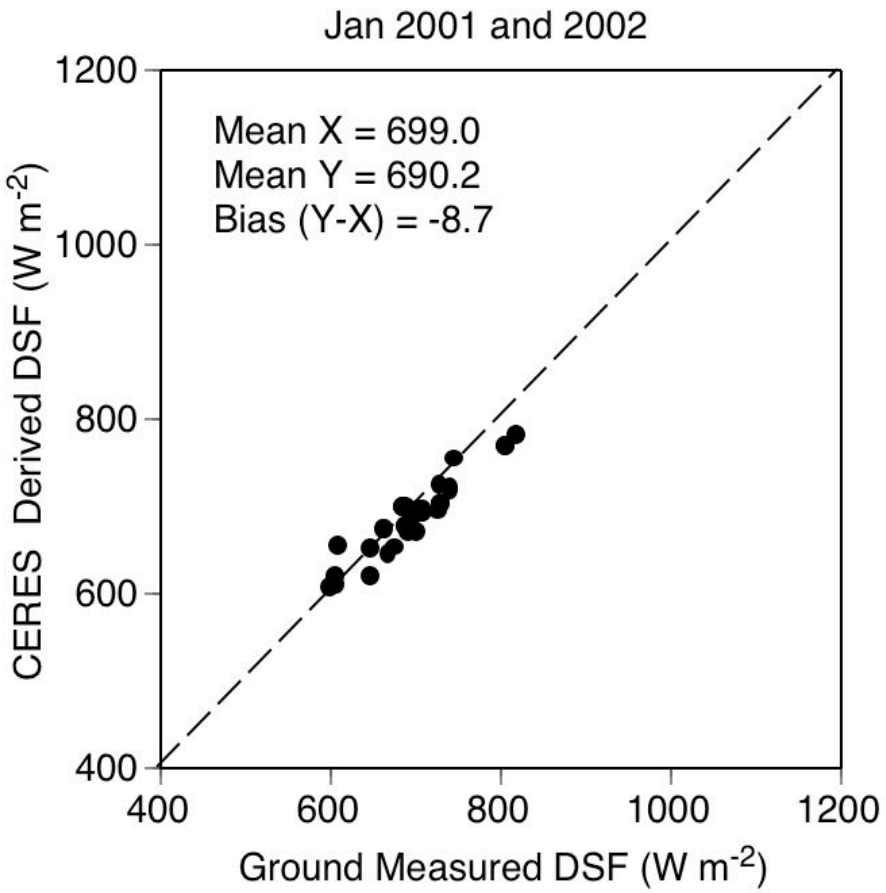
Objective: Develop monthly climatologies of broadband SW aerosol optical depth, single scattering albedo, and asymmetry parameter on a 1°x1° grid over the globe.

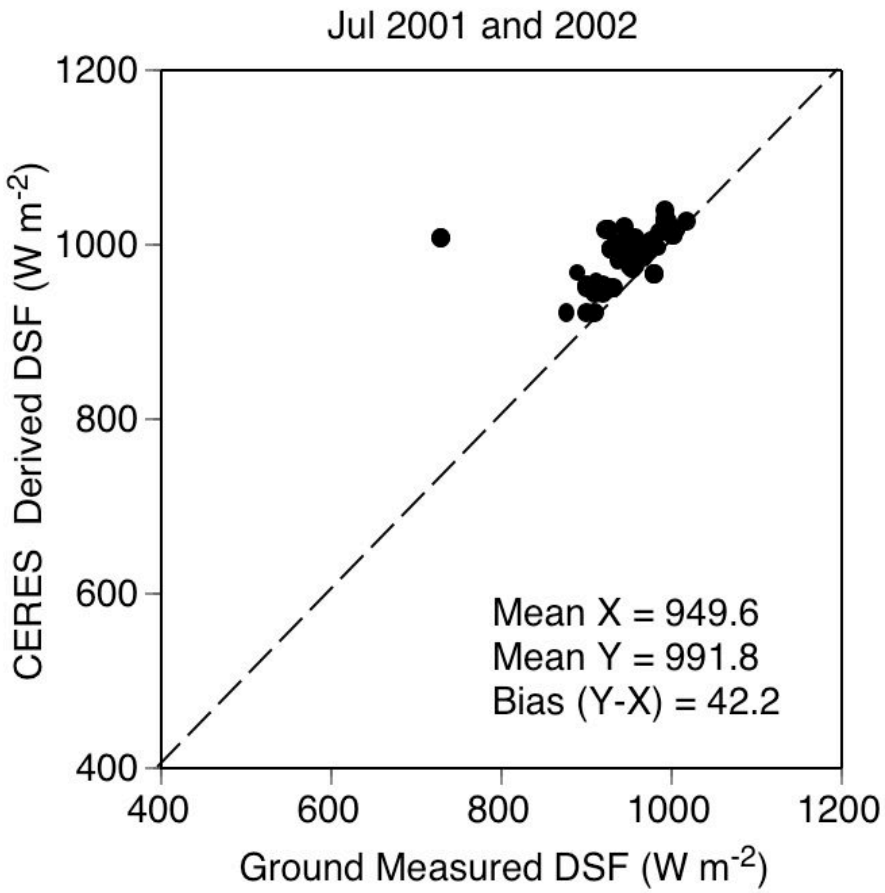
Motivation:

- Currently use a fast broadband SW radiation model (LPSA) to derive surface SW fluxes in CERES, GEWEX/SRB, and FLASHFlux processing.
- Aerosol properties in use are rudimentary, and cause large biases in some regions.
- Need to bring in more realistic aerosol properties.
- Preserving high speed of the model requires monthly climatologies instead of high temporal resolution.

Comparison of CERES Retrievals and Ground Data

(Saudi Solar Village; Terra/Clear-Sky)





Input Data and Sources

Optical Depths: Model for Atmospheric Transport and CHemistry (MATCH) Output - (W. Collins at NCAR; Data by: D. Fillmore)

What is Available: Daily fields of AOD for 10 different species and total aerosol at 550 nm for 42 months (Jan2000-Jun2003).

Spectral Optical Properties: Optical Properties of Aerosols and Clouds (OPAC) - Hess, Koepke, and Schult (1998): BAMS.

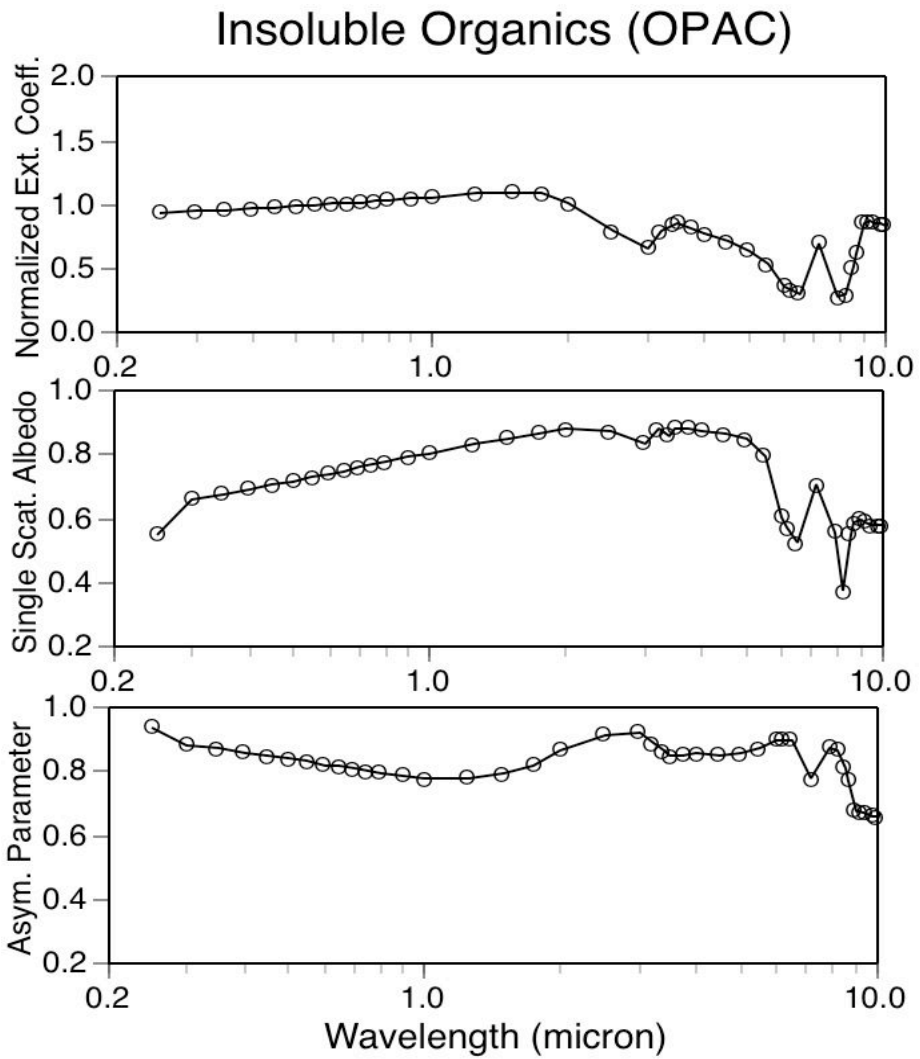
What is Available: Normalized extinction coefficient, single scattering albedo, and asymmetry parameter, spectrally tabulated in the 0.25 - 40.0 μm range for 10 or more species.

In Addition: Dust optical properties from Lacis (2004)

Correspondence Between Aerosol Species

MATCH Species	OPAC/Other Species	Optical Prop. Source
Dust (0.05-0.5 μm)	Fine Dust	Lacis (2004) (r_e = 0.3 μm)
Dust (0.5-1.25 μm) Dust (1.25-2.5 μm) Dust (2.5-5.0 μm)	Coarse Dust	Lacis (2004) (r_e = 1.0 μm)
Sulfate	Sulfate	OPAC
Sea Salt	Sea Salt	OPAC
Black C. (hydrophilic) Black C. (hydrophobic)	Soot	OPAC
Organic C. (hydrophilic)	Soluble Organics	OPAC
Organic C. (hydrophobic)	Insoluble Organics	OPAC

Spectral Optical Depths



$$\tau(\lambda) = e(\lambda)\,\tau(0.55)$$

Broadband Optical Properties

Optical Depth:

$$\tau(bb) = \frac{\int \tau(\lambda) S(\lambda)\, d\lambda}{\int S(\lambda)\, d\lambda}$$

Single Scattering Albedo:

$$\omega_0(bb) = \frac{\int \omega_0(\lambda)\tau(\lambda) S(\lambda)\, d\lambda}{\int \tau(\lambda) S(\lambda)\, d\lambda}$$

Asymmetry Parameter:

$$g(bb) = \frac{\int g(\lambda)\omega_0(\lambda)\tau(\lambda) S(\lambda)\, d\lambda}{\int \omega_0(\lambda)\tau(\lambda) S(\lambda)\, d\lambda}$$

where $S(\lambda)$ is the spectral solar flux

Total Broadband Optical Properties

Optical Depth:

$$\tau(bb)_t = \sum \tau(bb)_i$$

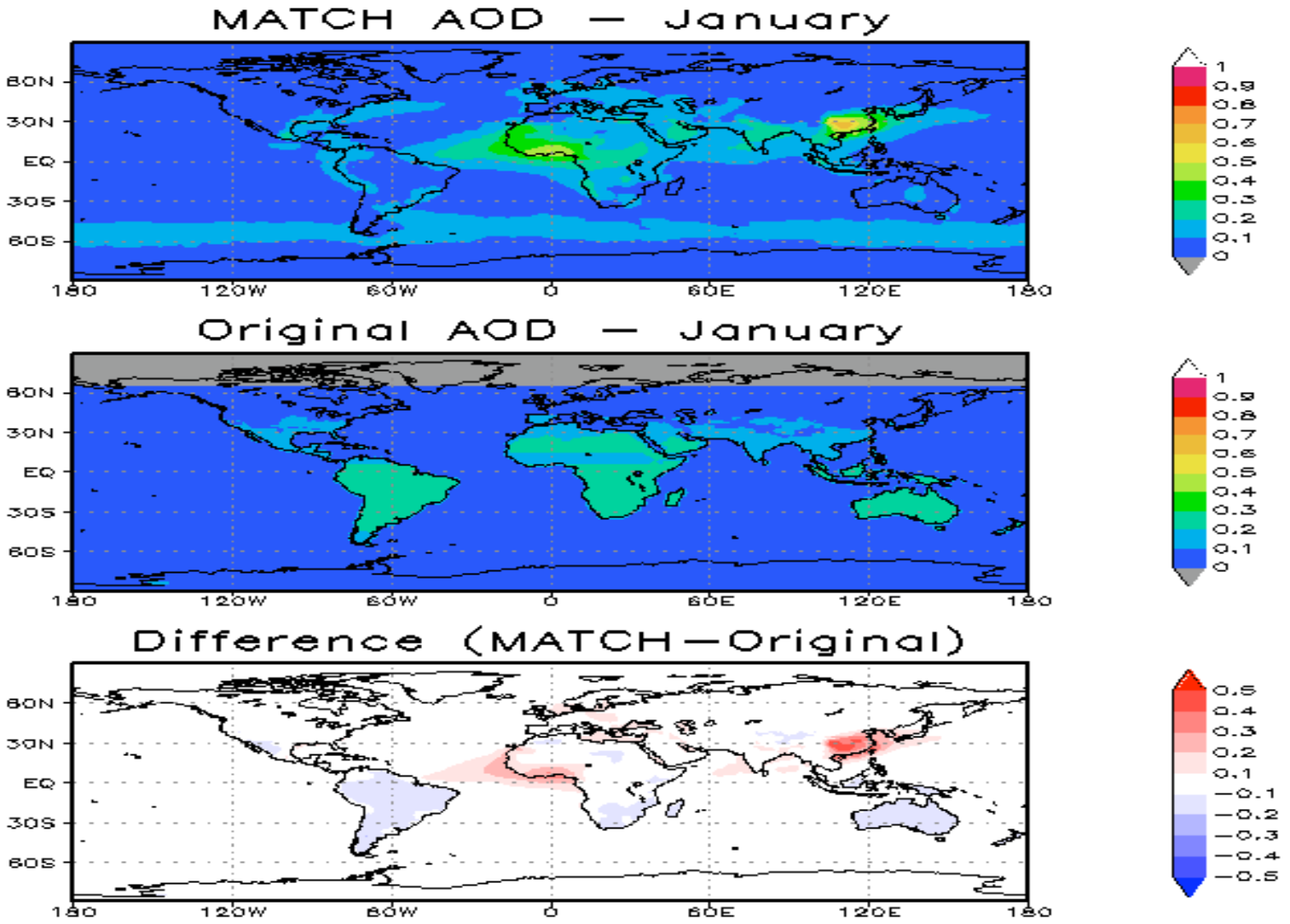
Single Scattering Albedo:

$$\omega_0(bb)_t = \frac{\sum \omega_0(bb)_i \, \tau(bb)_i}{\sum \tau(bb)_i}$$

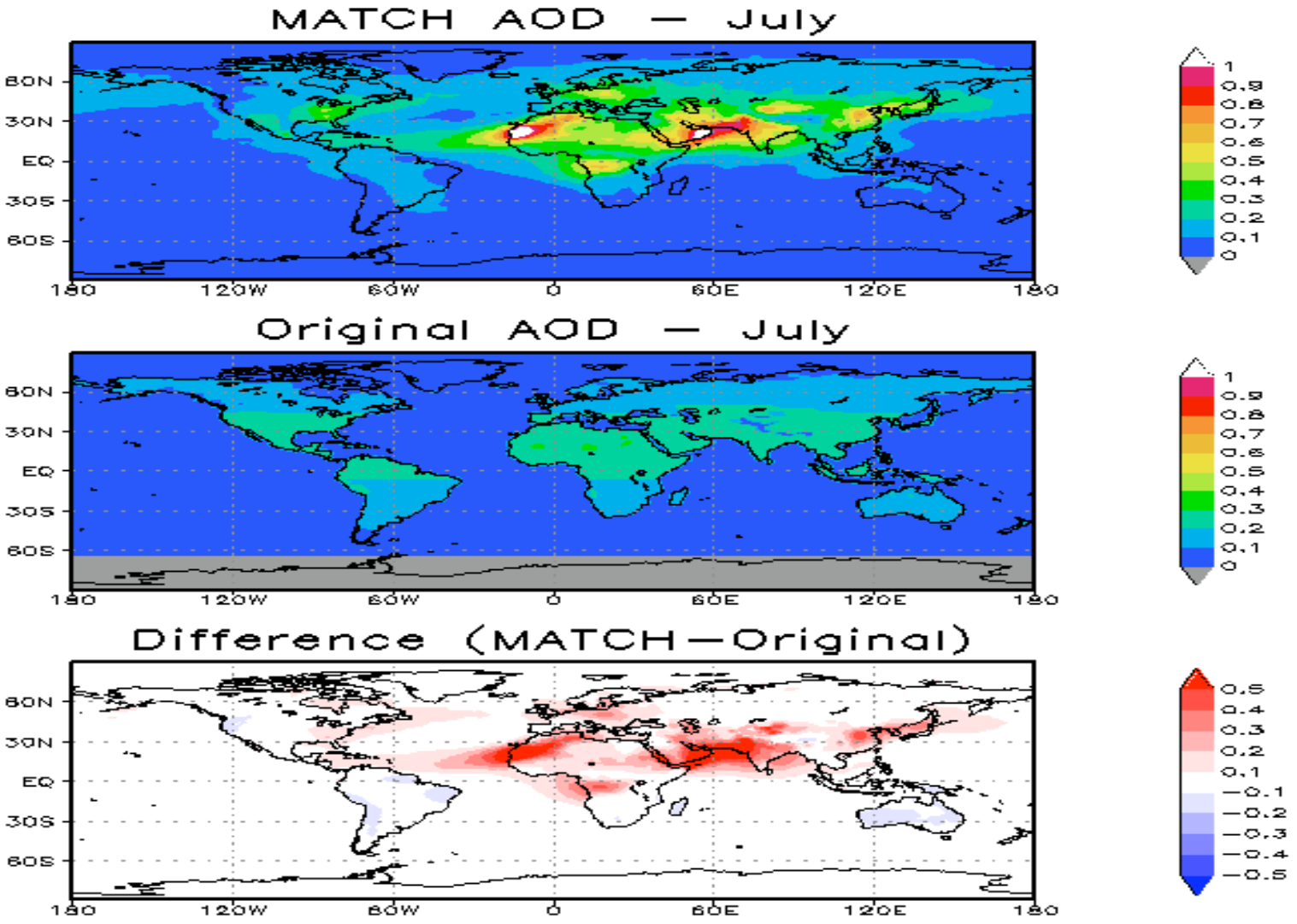
Asymmetry Parameter:

$$g(bb)_t = \frac{\sum g(bb)_i \, \omega_0(bb)_i \, \tau(bb)_i}{\sum \omega_0(bb)_i \, \tau(bb)_i}$$

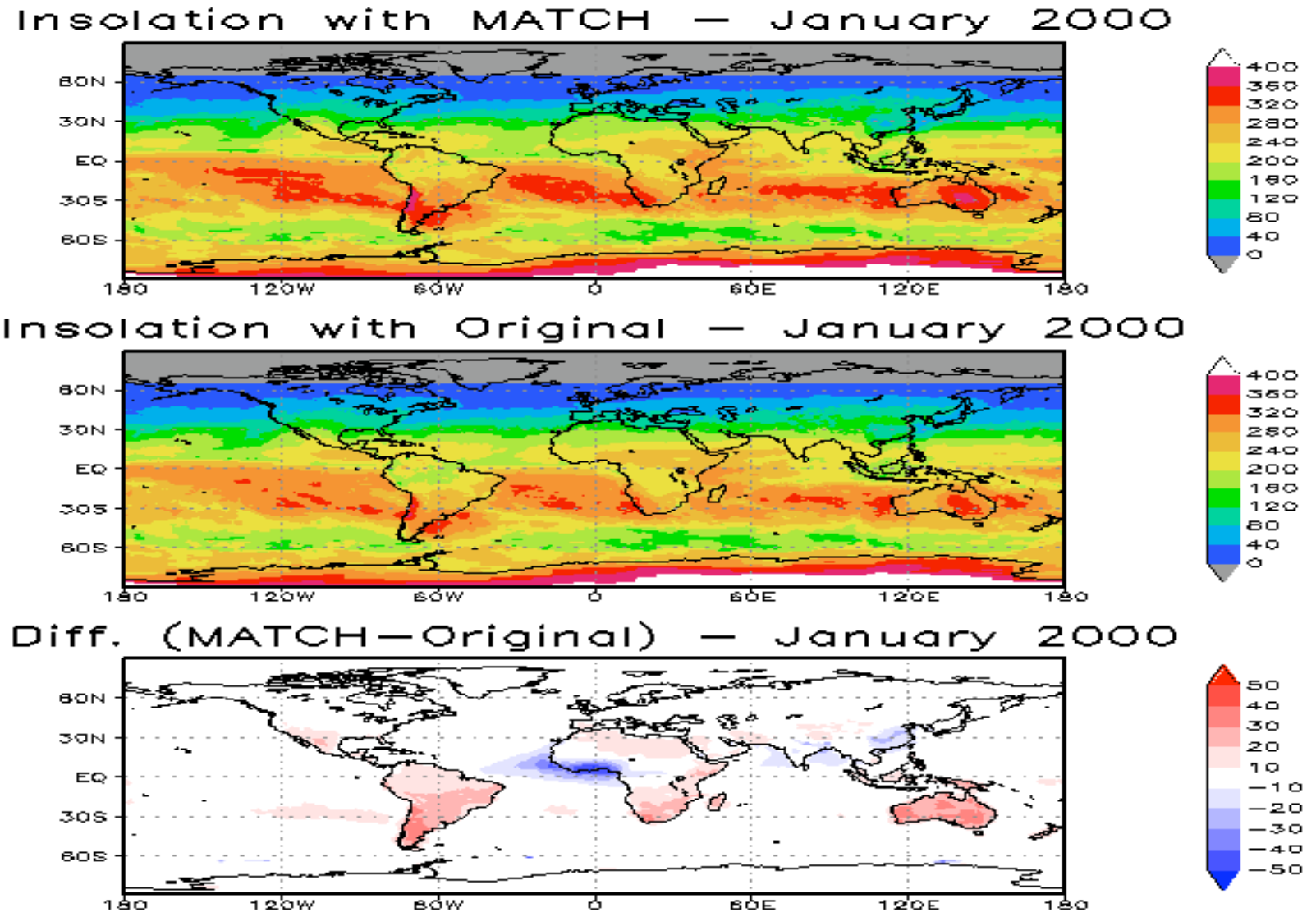
Total Broadband AOD -January



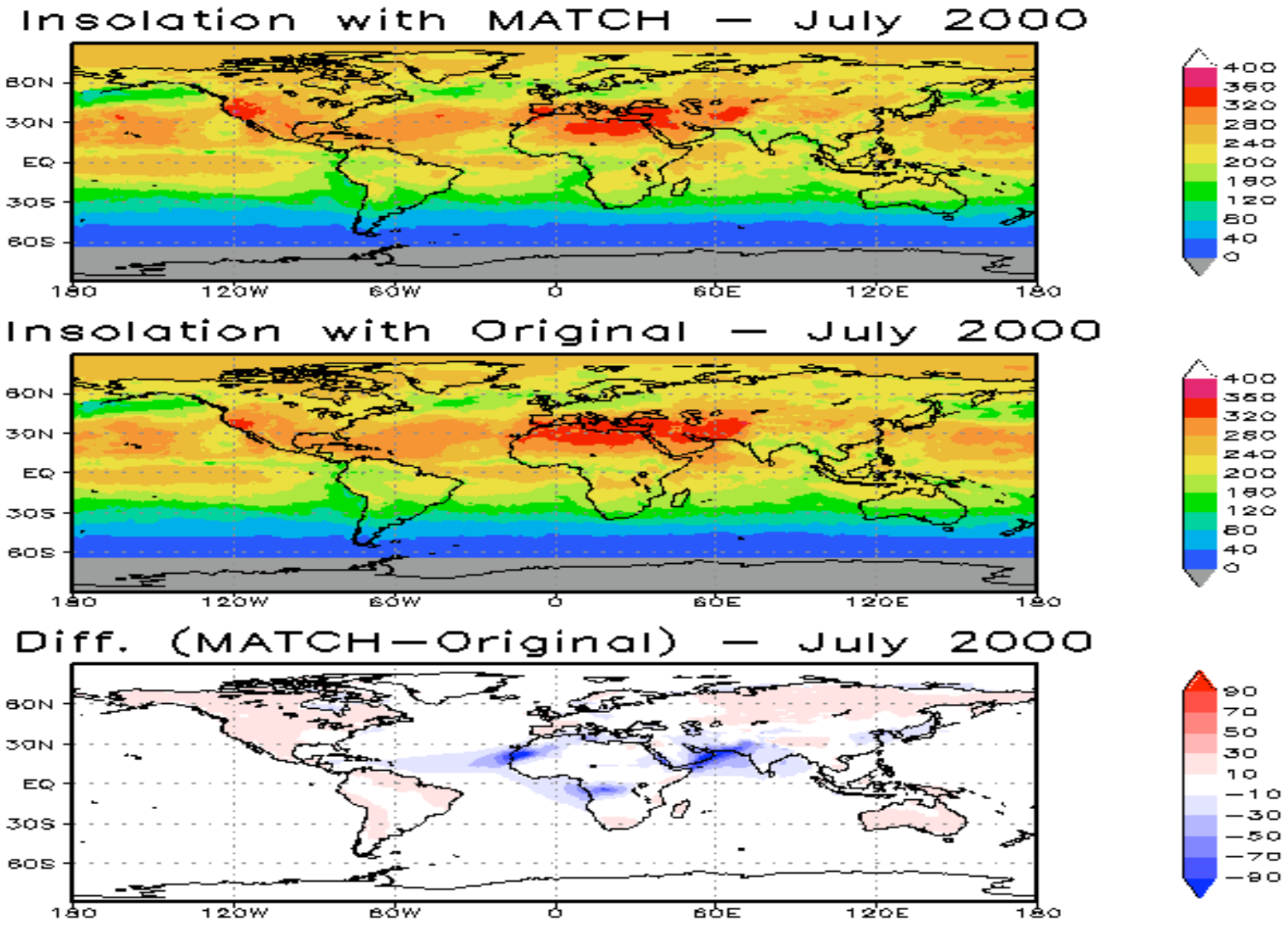
Total Broadband AOD -July



Surface Insolation - January 2000

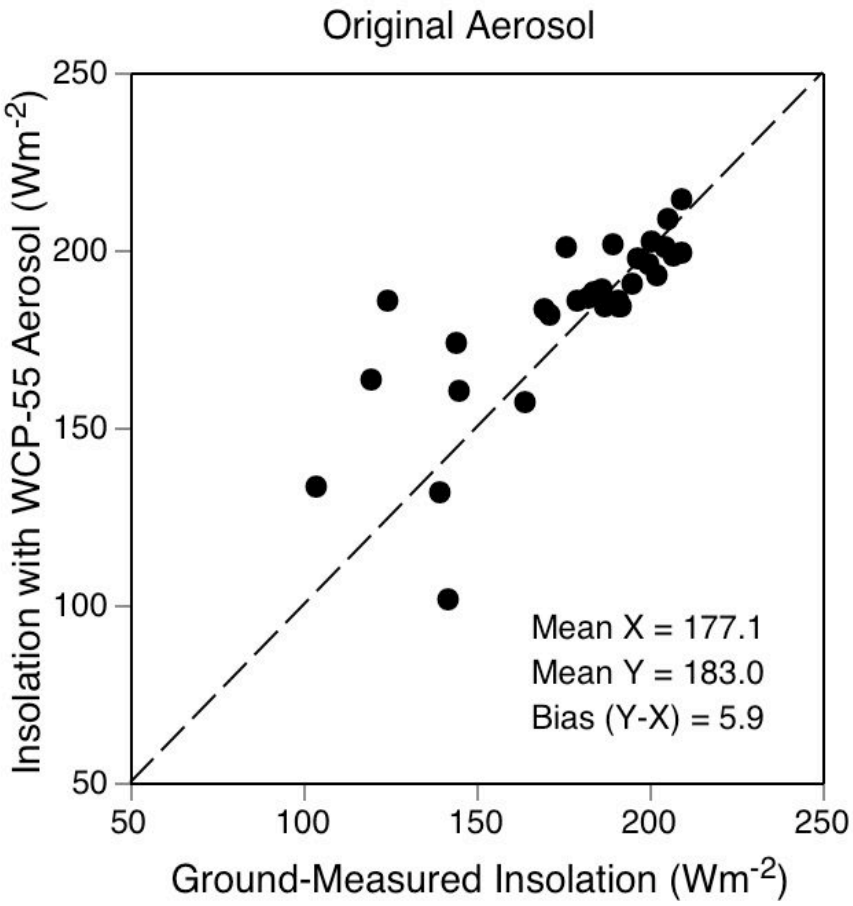


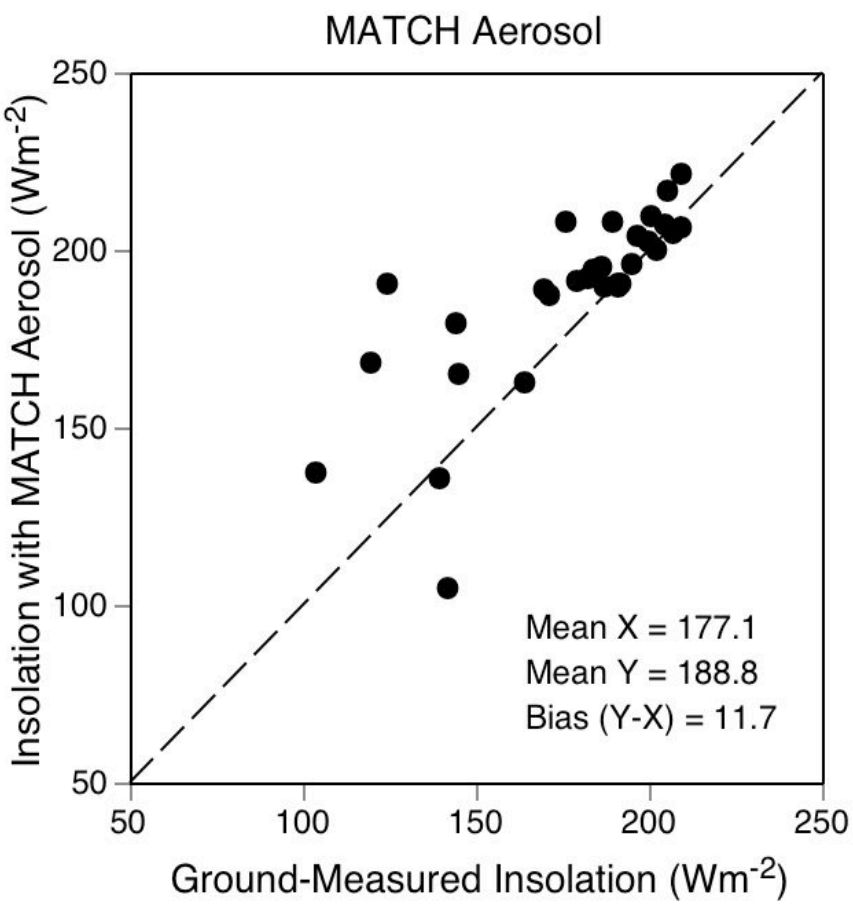
Surface Insolation - July 2000



Comparison of Daily Averages With Ground Data

(Saudi Solar Village - January 2000)





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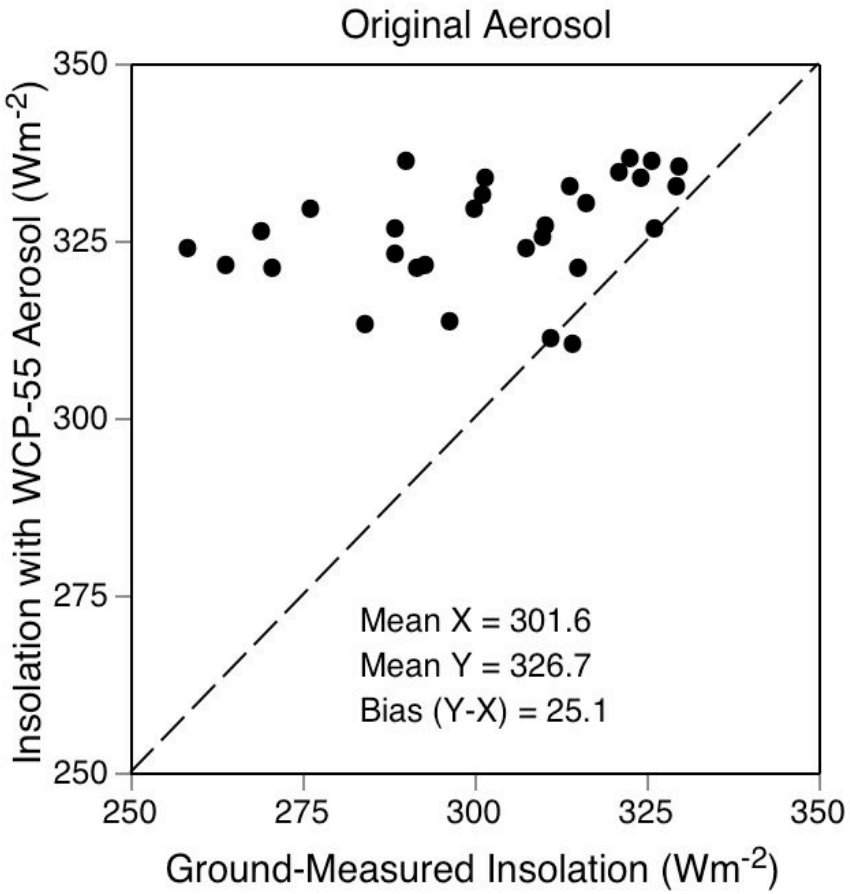

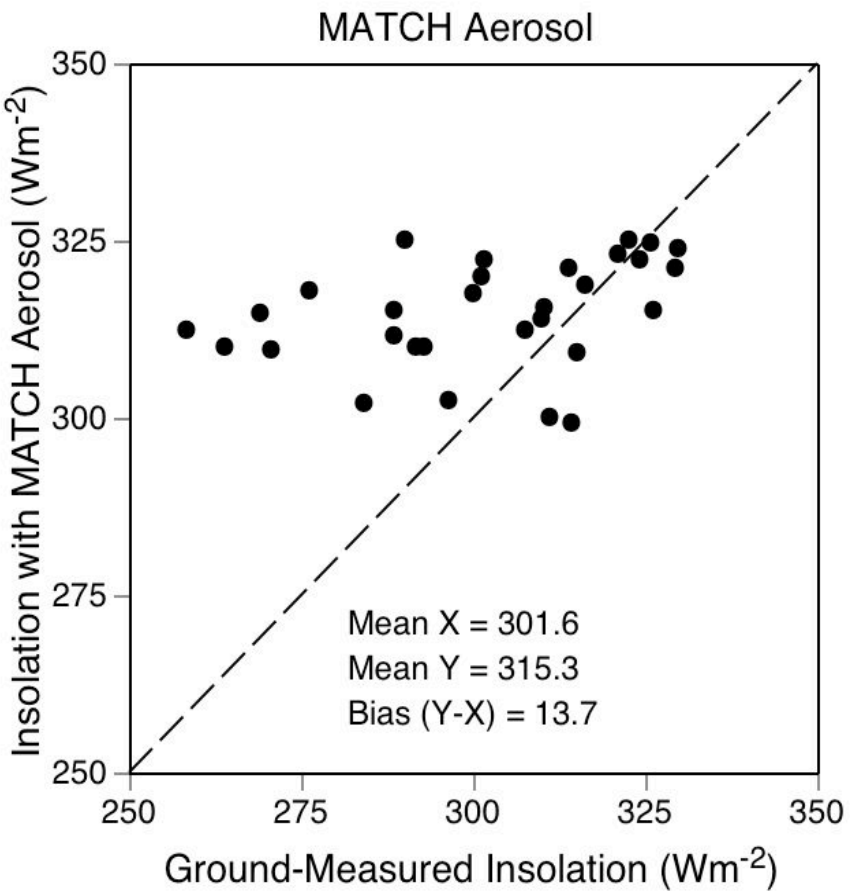

Summary

- **Produced monthly climatologies of broadband SW aerosol optical properties using:**

  AOD (550 nm) monthly climatologies from MATCH data

  Spectral optical properties from OPAC (Lacis 2004 for dust)

- **Started testing of AOD fields in the broadband SW model**

- **Testing is just beginning; results are very preliminary**

- **Detailed results to be presented at the next STM**